II
Dramatis Personae

HANS CHRISTIAN OERSTED, 1777–1851 (Plate I)

H. C. Oersted was born on 14 August 1777 in Rudkjöbing on the island of Langeland, off the east coast of Denmark. He attended the university of Copenhagen, from which he graduated as a pharmacist in 1797. He was awarded gold medals for essays in aesthetics and medicine and, in 1799, the degree of Ph.D. for a dissertation on Kant's philosophy. He was elected Professor at Copenhagen University in 1806 after extensive travelling abroad.

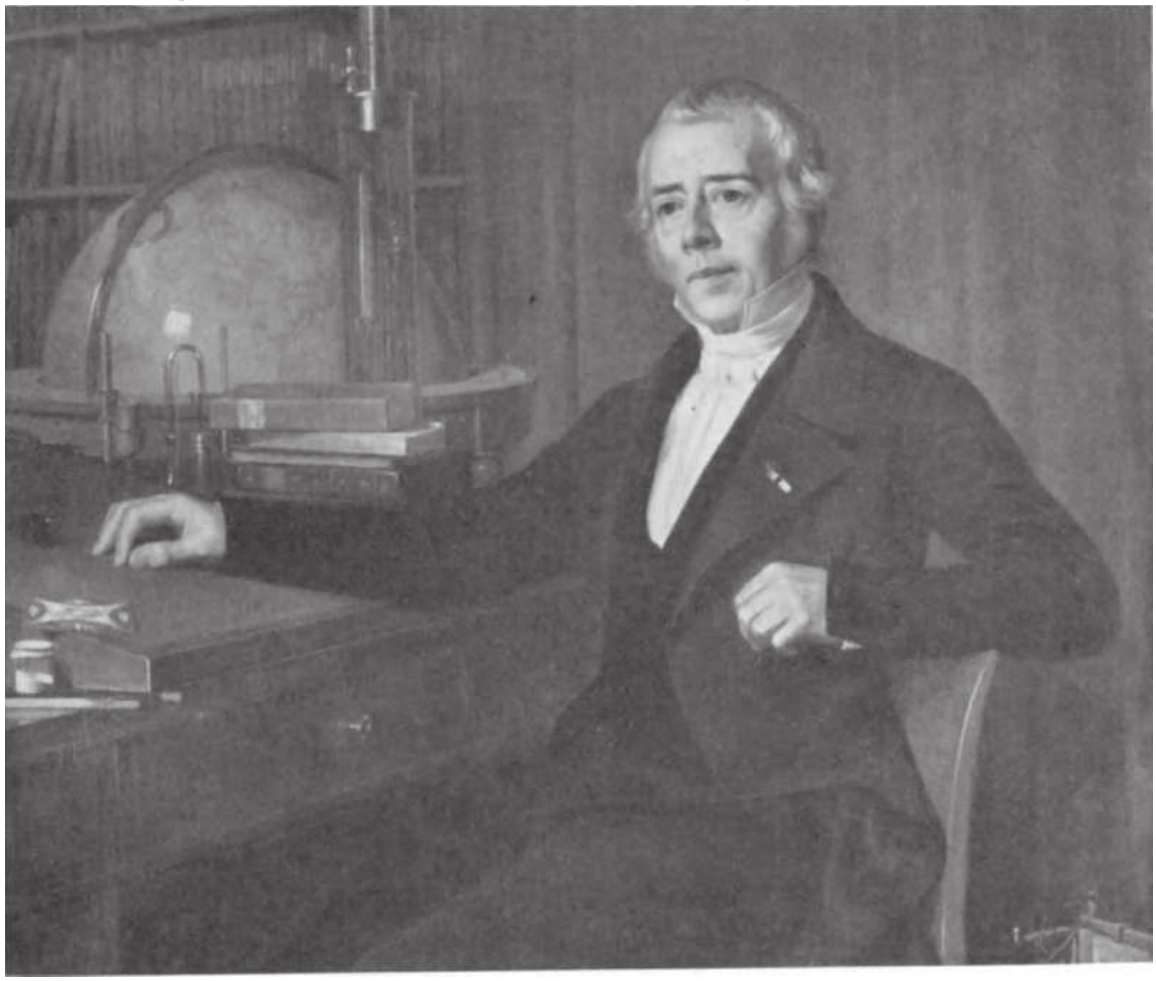

PLATE I. H. C. Oersted. From a portrait kindly provided by the Danske Tekniske Höjskole.

His most important contribution to science was his discovery of the action of an electric current on a compass needle. Of that there can be no doubt, and it will be that alone with which we shall be concerned in this book. To chemistry he contributed the preparation of metallic aluminium. He devoted much of his researches to a study of the compressibility of liquids and gases.

Oersted's researches in electricity were motivated by his metaphysical belief in the unity of the forces of nature. This, no doubt, he derived from the *Naturphilosophie* current in Germany at the beginning of the nineteenth century, the chief exponent of which was F. W. J. Schelling. This emphasized knowledge *a priori* and deprecated mere empirical knowledge, a view which Kant, whom Oersted had also studied, tended to support. It seems, indeed, a curious doctrine to inspire an experimental scientist. Oersted, trained as an apothecary, was, however, by no means uncritical of this depreciation of empirical knowledge. "Schelling wants to give us a complete philosophical system of physics but without any knowledge of nature except from textbooks."

His attempts to demonstrate the unity between galvanic and magnetic forces, however, were not successful until 1820. An account of what happened on that occasion has been given in a well-known letter to Michael Faraday from Professor Hansteen dated 30 December 1857.

"Professor Oersted (he wrote) was a man of genius but he was a very unhappy experimenter; he could not manipulate his instruments. He must always have an assistant, or one of his auditors, who had easy hands, to arrange the experiment. I have often, in this way, assisted him as his auditor.

"Already in the former century there was a general thought that there was a great conformity, and perhaps identity, between the electrical and magnetical force; it was only a question of how to demonstrate it by experiments. Oersted tried to place the wire of his galvanic battery perpendicular (at right angles to) over the magnetic needle, but marked no sensible motion. Once, after the end of his lecture, as he had used a strong galvanic battery in other experiments he said, 'Let us now once, as the battery is in activity, try to place the wire parallel to the needle'; as this was made, he was quite struck with perplexity by seeing the needle making a great oscillation (almost at right angles with the magnetic meridian). Then he said: 'Let us now invert the direction of the current' and the needle deviated in the contrary direction. Thus the great detection was made; and it has been said, not without reason, that 'he tumbled over it by

accident'. He had not before any more idea than any other person that the force should be transversal. But, as Lagrange has said of Newton on a similar occasion, 'Such accidents only meet persons who deserve them'."

This letter was, of course, written after a lapse of 37 years. There is one point in it which calls for comment. If Oersted disposed of currents which were great enough to deflect a compass nearly at right angles to the magnetic meridian, one might have imagined that he would have obtained a reversal of the needle on occasion, when he held the wire at right angles to the meridian. One would have thought, too, that even when the field of the current had the same direction as that of the earth, slight movements of the wire would have produced some movement in the needle which would have made it obvious that it was following the direction at right angles to the wire, rather than the field of the earth. It is possible that Professor Hansteen exaggerated the magnitude of the effect which Oersted was able to produce. In any case his account was not written until nearly 40 years after the event and may not be at all accurate.

Oersted himself has left three accounts of how he made his famous discovery, which agree among themselves but which are at variance with Professor Hansteen's description. An extract from the first of these, of which there are French and German editions, is as follows.

"Since for a long time I had regarded the forces which manifest themselves in electricity as the general forces of nature, I had to derive the magnetic effects from them also. As proof that I accepted this consequence completely, I can cite the following passage from my *Recherches sur l'identité des forces chimiques et électriques*, printed in Paris 1813. 'It must be tested whether electricity in its most latent state has any action on the magnet as such.' I wrote this during a journey so that I could not easily undertake the experiments; not to mention that the way to make them was not at all clear to me at that time, all my attention being applied to the development of a system of chemistry. I still remember that, somewhat inconsistently, I expected the predicted effect particularly from the discharge of a large electric battery and, moreover, only hoped for a weak magnetic effect. Therefore I did not pursue with proper zeal the thoughts I had conceived; I was brought back to them through my lectures on electricity, galvanism and magnetism in the spring of 1820. The auditors were mostly men already considerably advanced in science; so these lectures and the preparatory reflections led me on to deeper investigations than those which are admissible in ordinary lectures. Thus my former conviction of the identity of electrical and magnetic forces developed with

new clarity, and I resolved to test my opinion by experiment. The preparations for this were made on a day in which I had to give a lecture the same evening. I therefore showed Canton's experiment on the influence of chemical effects on the magnetic state of iron. I called attention to the variations of the magnetic needle during a thunderstorm, and at the same time I set forth the conjecture that an electric discharge could act on a magnetic needle placed outside the galvanic circuit. I then resolved to make the experiment. Since I expected the greatest effect from a discharge associated with incandescence, I inserted in the circuit a very fine platinum wire above the place where the needle was located. The effect was certainly unmistakable, but it seemed to me so confused that I postponed further investigation to a time when I hoped to have more leisure.† At the beginning of July these experiments were resumed and continued without interruption until I arrived at the results which have been published."

About 2 months after the first announcement, Oersted submitted a second paper to the Académie des Sciences. It was received on 29 September 1820, 25 days after Arago had announced Oersted's discovery. By that time Ampère had already announced—on 25 September—the mutual action of two currents.

†"All my auditors are witnesses that I mentioned the result of the experiment beforehand. The discovery was therefore not made by accident, as Professor Gilbert has wished to conclude from the expressions I used in my first announcement."